R^3

Rugged, Resilient Residences

Evan Mills
LBNL • Residential Building Systems Group

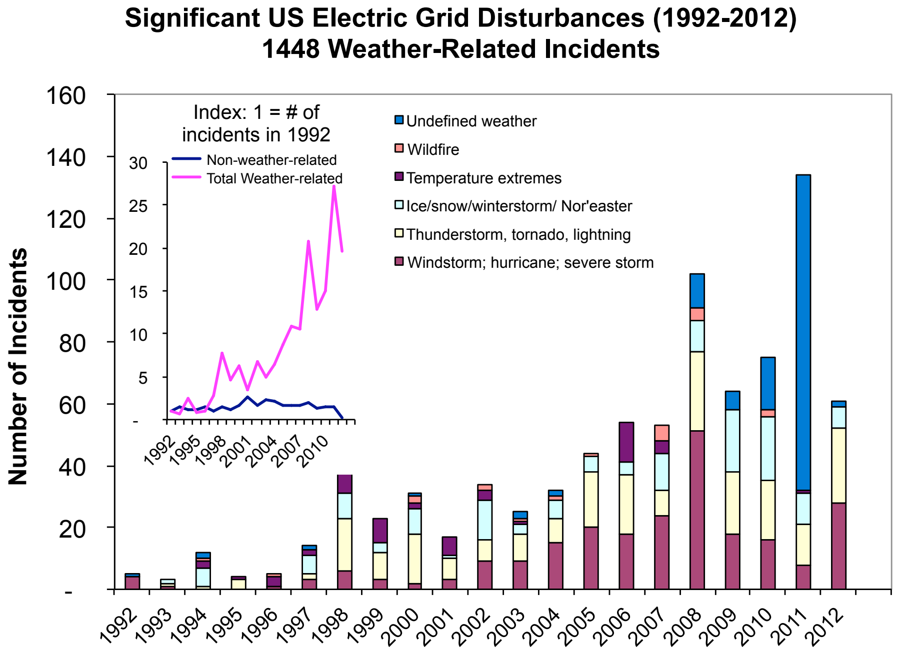
Briefing for DOE Building Technologies Office
April 22, 2013

Resilient is not necessarily green …
… and green is not necessarily resilient

A ruined building is not a green building

And there are limits to adaptation

Power outages are a cross-cutting concern

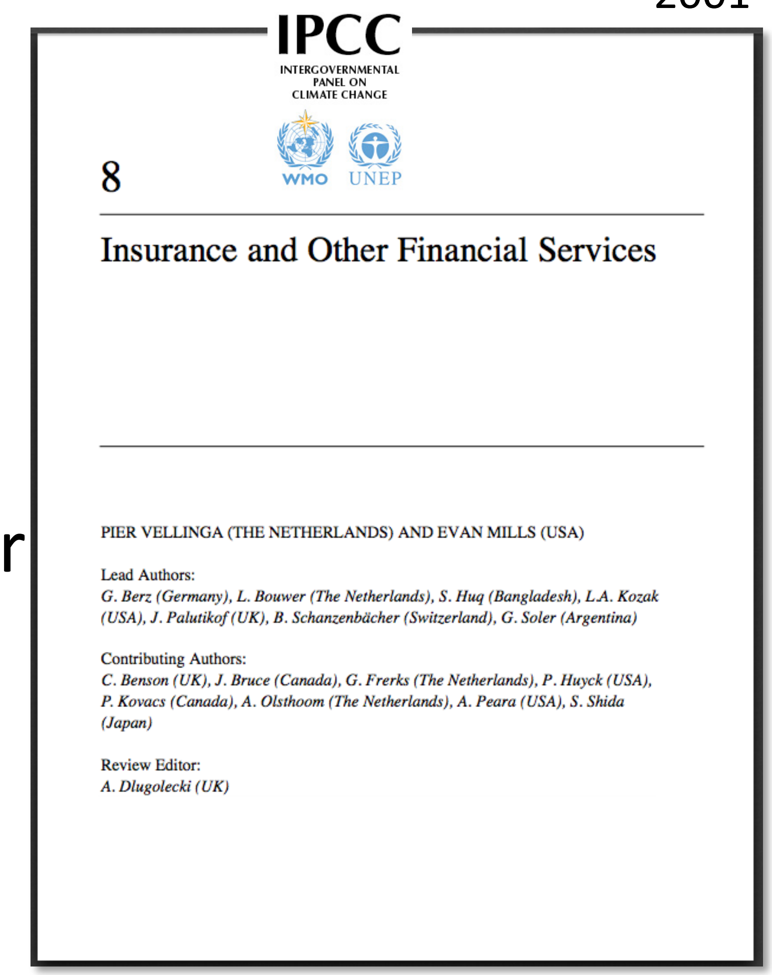


Note: these are outages reported to EIA and not a full sample of all events.

Climate change makes matters worse

- Increased event frequency
- Increased event intensity
- Changing geography of exposures
- More complex impacts
  - (water > wind > fire>blackout)
- New challenges to the indoor environment
- Economic hardship (e.g., unaffordability or unavailability of insurance; lengthier business interruptions)

2001


IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO UNEP

8

Insurance and Other Financial Services

PIER VELLINGA (THE NETHERLANDS) AND EVAN MILLS (USA)

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Considerations in thinking about roles for EERE technologies and practices

- The need for resilience extends beyond natural disaster situations, e.g., to small-scale events such as house fires, gradual deterioration of housing stock, etc.
- Costs are shouldered by a diversity of players
  - Consumers
  - Insurers
  - Public entities (federal/state/local)
  - … and the "ROI" perspective is entirely different
    (think of the cost-benefit analysis on a backup generator)
- Measures can be interjected at various levels
  - Equipment
  - Envelope
  - Whole house
  - Neighborhood
  - Cityscape

Downsides should not be ignored

- Solar panels blowing off rooftops
- Excessive complexity of measures => unreliability
- Inadvertently compromised IAQ
- Liability for underperformance
- Adaptations that cause energy use to increase (e.g., more AC), or water use (evaporative cooling)
- Insurers tend to over-think downside risks; but have at least proactively launched products to manage them

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On Climate Change, a Do-Nothing Strategy is Not Risk-Free

BY EVAN MILLS
March 13, 2013 • Reprints

Beyond mitigating climate change, green technologies can even reduce conventional risks. Many insurers note that dual-paned windows are more fire-safe than single-paned ones (failing more slowly under heat stress, thereby helping block and keep down the supply of air to the fire). Pay-as-you-drive insurance helps reduce emissions from cars by rewarding reduced driving while lowering the probability of accidents. There is a long list of similar win-win strategies.

Insurers are even finding that some strategies reduce emissions while helping directly fortify infrastructure against climate change impacts. Tokio Marine knows this, and has for over a decade been replanting mangrove forests across seven Pacific-rim countries for the dual purposes of pulling carbon-dioxide out of the atmosphere and reducing storm damages.

To do this right, insurers will want to look squarely at the whole constellation of responses to climate change and consider their *comparative* risks. There is a colorful cast of characters. Energy efficiency is arguably the most risk-free climate change response strategy. It doesn't hurt that it saves money as well. It mitigates risks such as vulnerability to forced power plant shutdowns during droughts and heat waves or weapons proliferation and fuel-import vulnerabilities posed by (mostly) carbon-free nuclear power. In fact, targeted efficiency makes the electric grid more robust and helps customers weather power outages.

Sadly, as proven methods of trimming emissions are delayed, concerned scientists and policymakers are increasingly looking to more desperate approaches such as "solar radiation management" by continuously dumping dust from high-altitude jets into the atmosphere or flinging *trillions* of reflective Frisbees into space (I kid you not) to block incoming solar energy, or dumping megatons of iron filings into the ocean to capture carbon in massive carbon-capturing algae blooms. These strategies are feared to usher in a variety of unintended side effects such as drought—not to mention fostering complacency. It will be interesting to see whether private companies proposing to conduct this work will be successful in obtaining insurance.

With burgeoning climate risks, a do-nothing strategy is of course not risk-free. The wisest response is to "greenline" emissions-reduction technologies rather than "redlining" them.

« Previous Page 2 of 2

ABOUT THE AUTHOR
Evan Mills

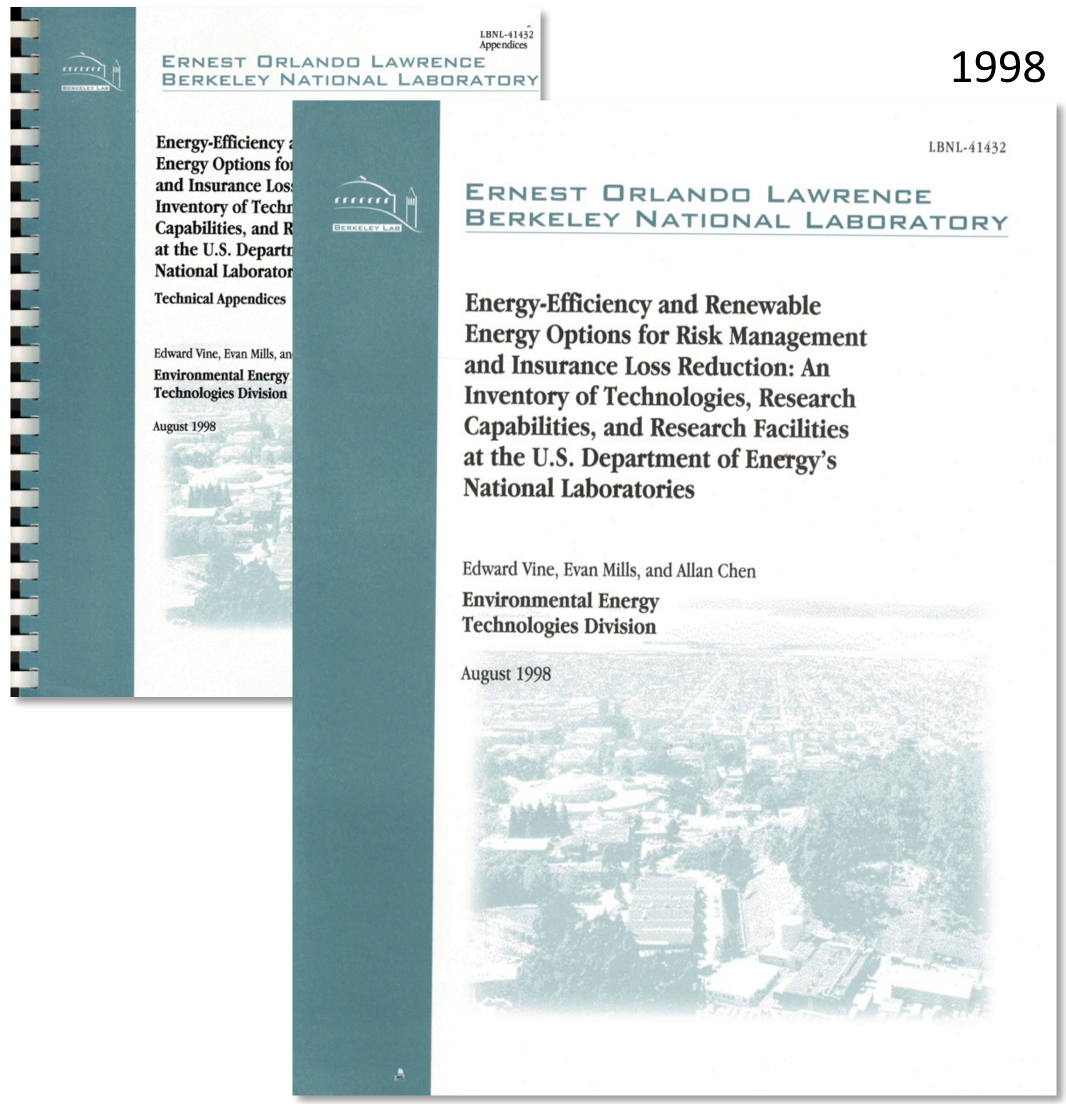
Evan Mills is a scientist at the U.S. Department of Energy's Lawrence Berkeley National Lab, University of California. He received a Masters of Science degree from the Energy and Resources Group (where he is now a Research Affiliate) at the University of California at Berkeley in 1987 and a Ph.D. from the Department of Environmental and Energy Systems Studies under Thomas B. Johansson at the University of Lund in Sweden in 1991. Mills is a member of the international body of scientists which has worked under the Intergovernmental Panel on Climate Change (IPCC), which collectively shared in the Nobel Peace Prize for 2007 with former U.S. Vice President Al Gore.

That said, risks of "EERE" technologies are far lower than those associated with other climate change responses

In the 1990s, at EERE's request, we explored potential roles for the insurance industry in mobilizing efficient and renewable technologies for enhanced resilience

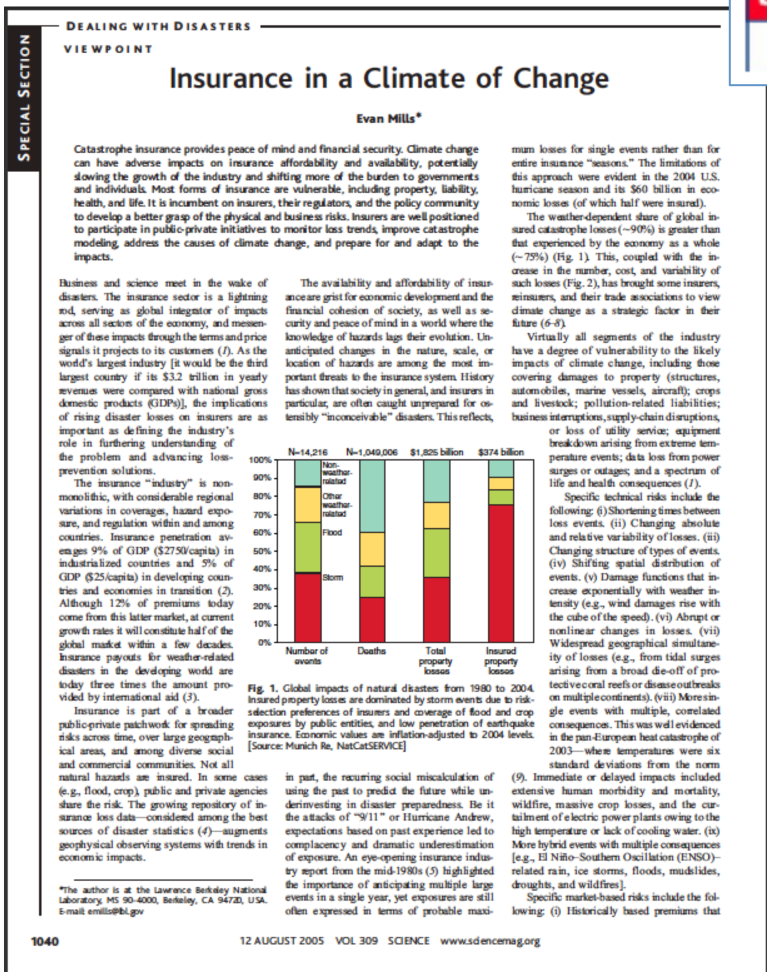
- 9 National Labs
  - ANL
  - BNL
  - INEEL
  - LBNL
  - LLNL
  - NREL
  - ORNL
  - PNNL
  - SNL
- 50+ relevant assessment capabilities
- Findings
  - 78 technologies
  - 8 hazards
  - 15 types of insurance losses that can be mitigated

1998



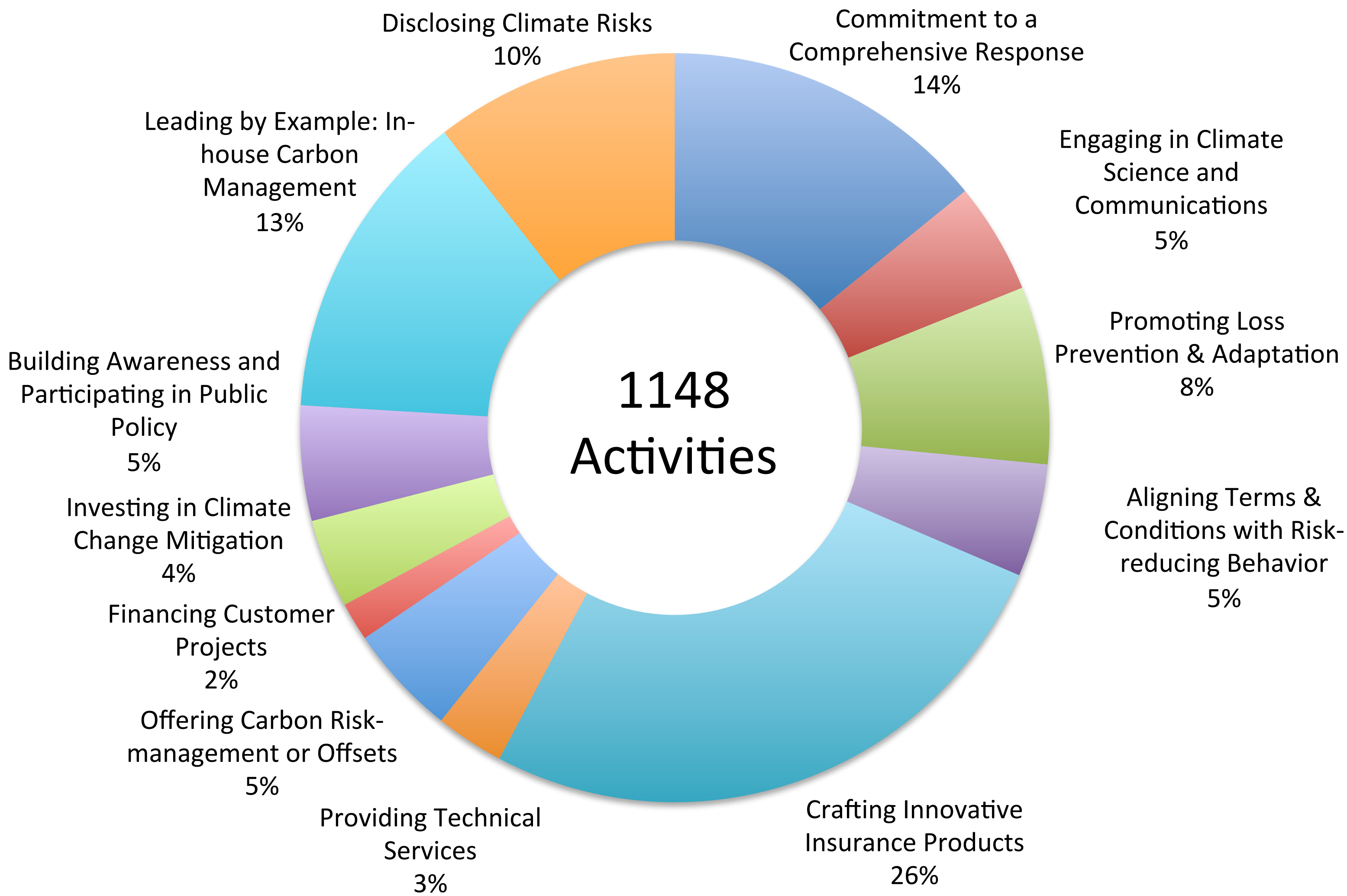
We pursued a wider effort to engage with the insurance industry

2005



2012

We identified and tracked a remarkable level of insurer engagement, globally



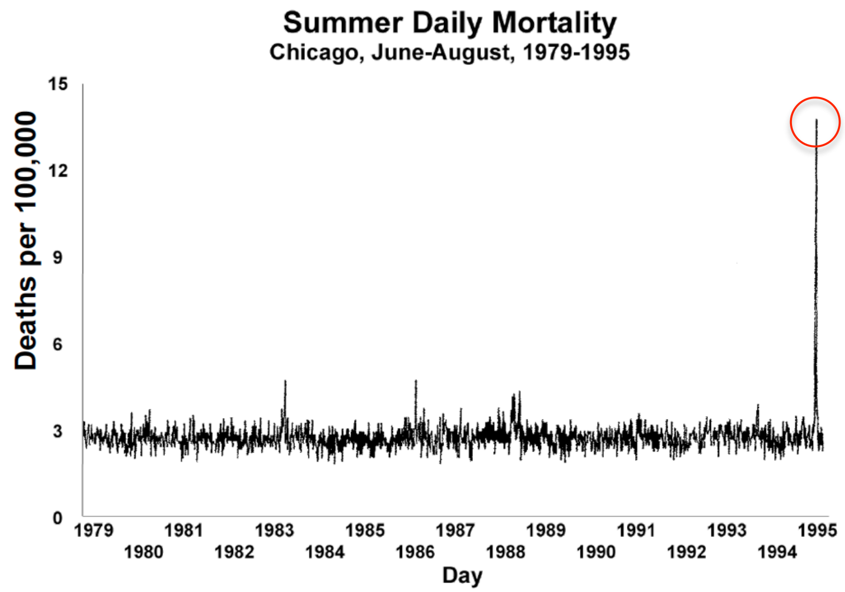
Resilience-Efficiency Co-benefits ?

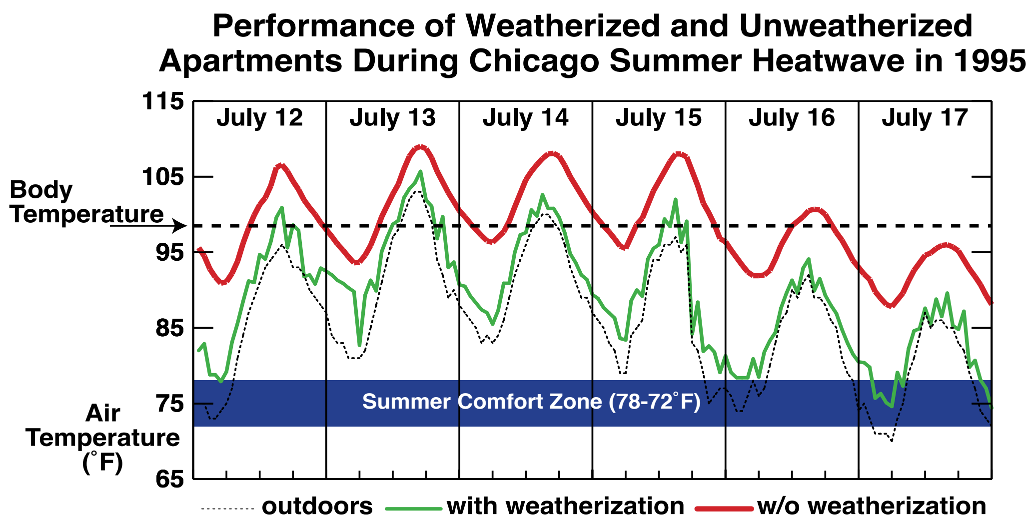
Framework & examples

	Reducing Physical Damages & Injury									
	Fire entry from outside	**Fire genesis inside**	**Earthquake damage**	**Wind-damage**	**Moisture damage**	**Perished footstuffs**	**Heat illness or mortality**	**Cold extremes**	**Ice Dams**	**Outdoor air quality**
Air-sealing		x			x					x
EE windows	x						x	x		
Water pipe insulation					x			x		
Efficient envelope								x	x	
Cool roof							x			
HRV								x		
Efficient lighting / battery backup									x	
Shading							x			
Closed-cell insulation			x	x	x					
Passive solar space conditioning and cooling		x								
Solar DHW		x								
Efficient refrigeration						x				
Water-efficient appliances and fixtures										
PV grid-intertie bypass										
House-integrated EV battery										

1. Heat mortality: Chicago 1995

- Risk
  - Heat is #1 extreme-weather killer in US
  - People often die because of conditions <u>inside</u> homes
- Solutions
  - Improved thermal integrity
  - Cool roofing
  - Natural ventilation

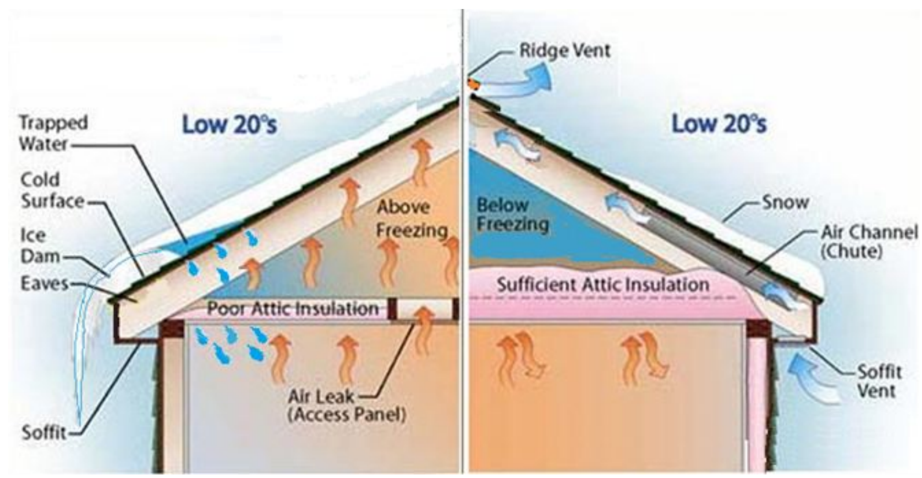




Analysis by Joe Huang, LBNL

2. Ice dams

- Risk
  - Heat loss melts rooftop snow, refreezing at cold eaves and causing water intrusion
- Solutions
  - Improve insulation
  - Reduce air leakage
  - Eliminate bypasses
  - Reduce duct losses
  - More efficient recessed lights

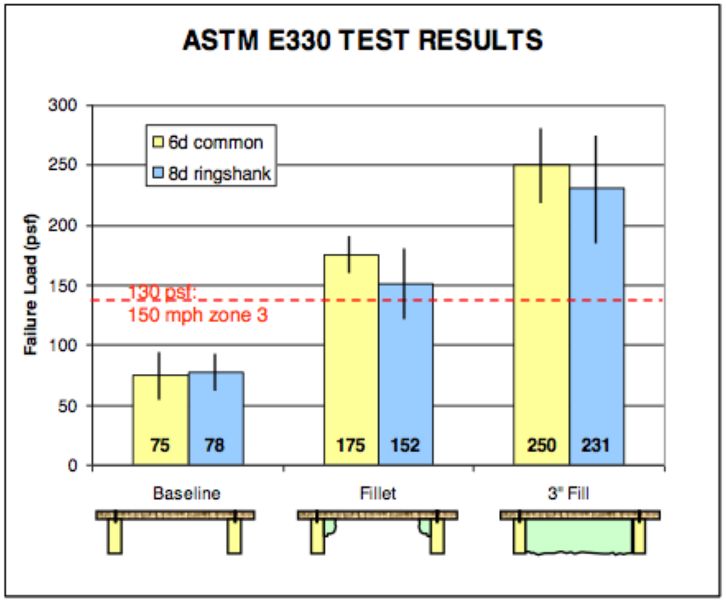


3. Roof failure in windstorms

- Risk
  - Roof deck failures are leading cause of residential building loss in hurricanes

Houses with damaged or missing roof sheathing in Florida

- Solutions
  - Closed-cell foam for improved adhesion



University of Florida, International Hurricane Research Center

4. Fire and glazing systems

- Risk
  - Failure of window in fire is big correlate of damage extent

- Solutions
  - Multi-pane systems shown to fail more slowly due to heat stress under fire
  - Tests by Pilkington (Sweden) found 2-glazed, low-e systems to take 3-4x longer to fail under fire than 2-glazed alone (?!)

5. Fire and halogen lighting

- Risks
  - Circa 1995, the popularity boom of halogen torchieres was associated with hundreds of structural fires
  - Lamp temperatures ~1000F
  - Insurers turned to LBNL for ideas

- Solutions
  - CFLs eliminated the heat source (and saved energy).
  - CFL torchieres became popular with risk managers responsible for university dormitories. Fire risks spurred RD&D

Keystone concept: Sheltering in Place

- The ability to shelter in place includes not only averting physical damage, but also:
  - Electronic communications
  - Comfort
  - Moisture protection
  - Evening illumination
  - On-site water
  - Active refrigeration
  - Sump pumps
  - Alarm systems

Most of these have to do with energy services. Standard "supply side" response is to buy a generator. Issues: cost, safety, reliability, fuel availability/viability, pollution

Framework & examples

	Reducing Physical Damages & Injury									
	Fire entry from outside	Fire genesis inside	Earthquake damage	Wind-damage	Moisture damage	Perished footstuffs	Heat illness or mortality	Cold extremes	Ice Dams	Outdoor air quality
Air-sealing		x			x					x
EE windows	x						x	x		
Water pipe insulation					x			x		
Efficient envelope								x	x	
Cool roof							x			
HRV								x		
Efficient lighting / battery backup									x	
Shading							x			
Closed-cell insulation			x	x	x					
Passive solar space conditioning and cooling		x								
Solar DHW		x								
Efficient refrigeration						x				
Water-efficient appliances and fixtures										
PV grid-intertie bypass										
House-integrated EV battery										

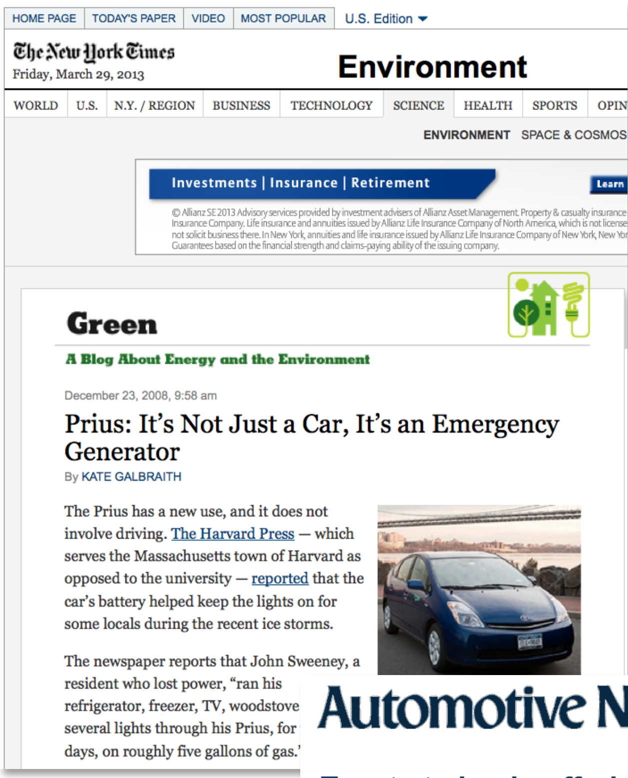
Shelter-in-place applications

Irrespective of backup power source, energy efficiency across all end uses (particularly critical ones) extends time that services can be maintained.

	Reducing Physical Damages & Injury										Services / Shelter-in-Place
	Fire entry from outside	Fire genesis inside	Earthquake damage	Wind-damage	Moisture damage	Perished footstuffs	Heat illness or mortality	Cold extremes	Ice Dams	Outdoor air quality	Need to evacuate home (Shelter in-place)
Air-sealing		x			x					x	x
EE windows	x						x	x			x
Water pipe insulation					x			x			x
Efficient envelope								x	x		x
Cool roof							x				x
HRV								x			x
Efficient lighting / battery backup									x		x
Shading							x				x
Closed-cell insulation			x	x	x						x
Passive solar space conditioning and cooling		x									x
Solar DHW		x									x
Efficient refrigeration						x					x
Water-efficient appliances and fixtures											x
PV grid-intertie bypass											x
House-integrated EV battery											x

15k house fires each year are caused by candles, ~30% of which occur during power outages

Off-grid power while sheltering in place



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The New York Times
Friday, March 29, 2013

Environment

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Green

A Blog About Energy and the Environment

December 23, 2008, 9:58 am

Prius: It's Not Just a Car, It's an Emergency Generator

By KATE GALBRAITH

The Prius has a new use, and it does not involve driving. The Harvard Press — which serves the Massachusetts town of Harvard as opposed to the university — reported that the car's battery helped keep the lights on for some locals during the recent ice storms.

The newspaper reports that John Sweeney, a resident who lost power, "ran his refrigerator, freezer, TV, woodstove several lights through his Prius, for days, on roughly five gallons of gas."

Automotive News

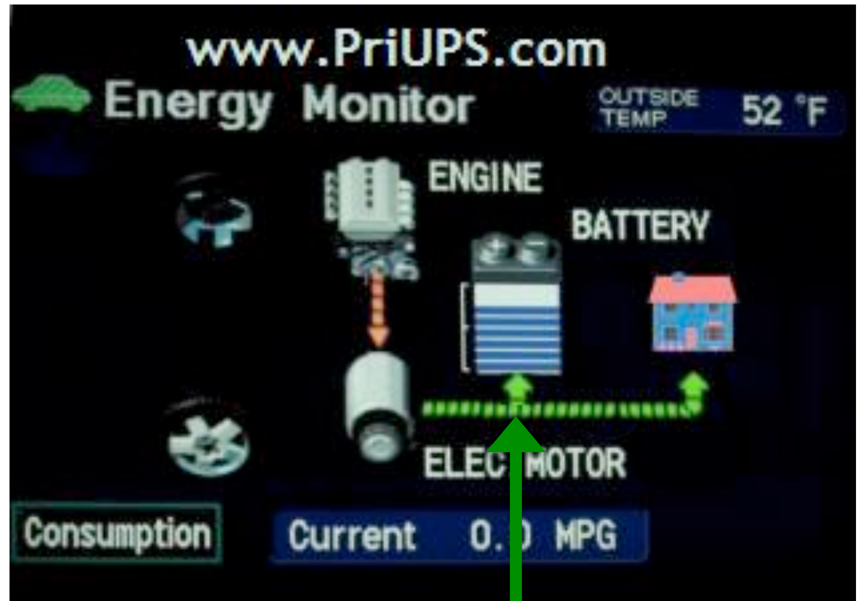
Toyota to begin offering AC outlets on the Prius in Japan

Hans Greimel -- Follow Hans on twitter
Automotive News | July 19, 2011 - 9:01 am EST

SENDAI, Japan -- How's this for a more user-friendly hybrid?

Next year, Toyota Motor Corp. will start offering AC electric outlets as an option on its popular Prius hybrid so drivers can plug in household appliances -- from computers to refrigerators.

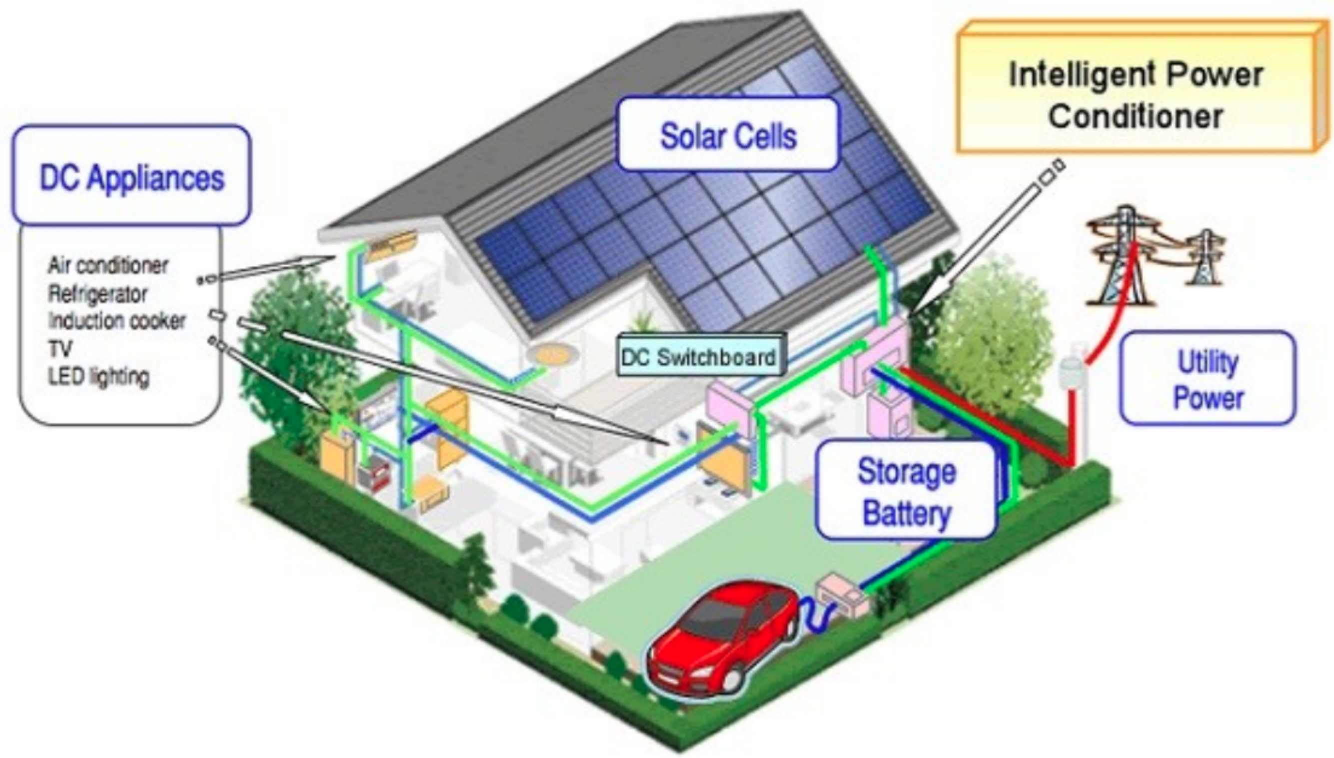
The idea was born from watching victims of Japan's March 11 earthquake using the Toyota Estima hybrid van as a source of emergency electricity when the power was knocked out.



Private industry is seeing opportunities

Sharp's Intelligent Power Conditioner works with EVs to make your house a lean, mean, solar-powered machine

By **Michael Gorman** posted Feb 23rd, 2011 at 1:13 PM 0



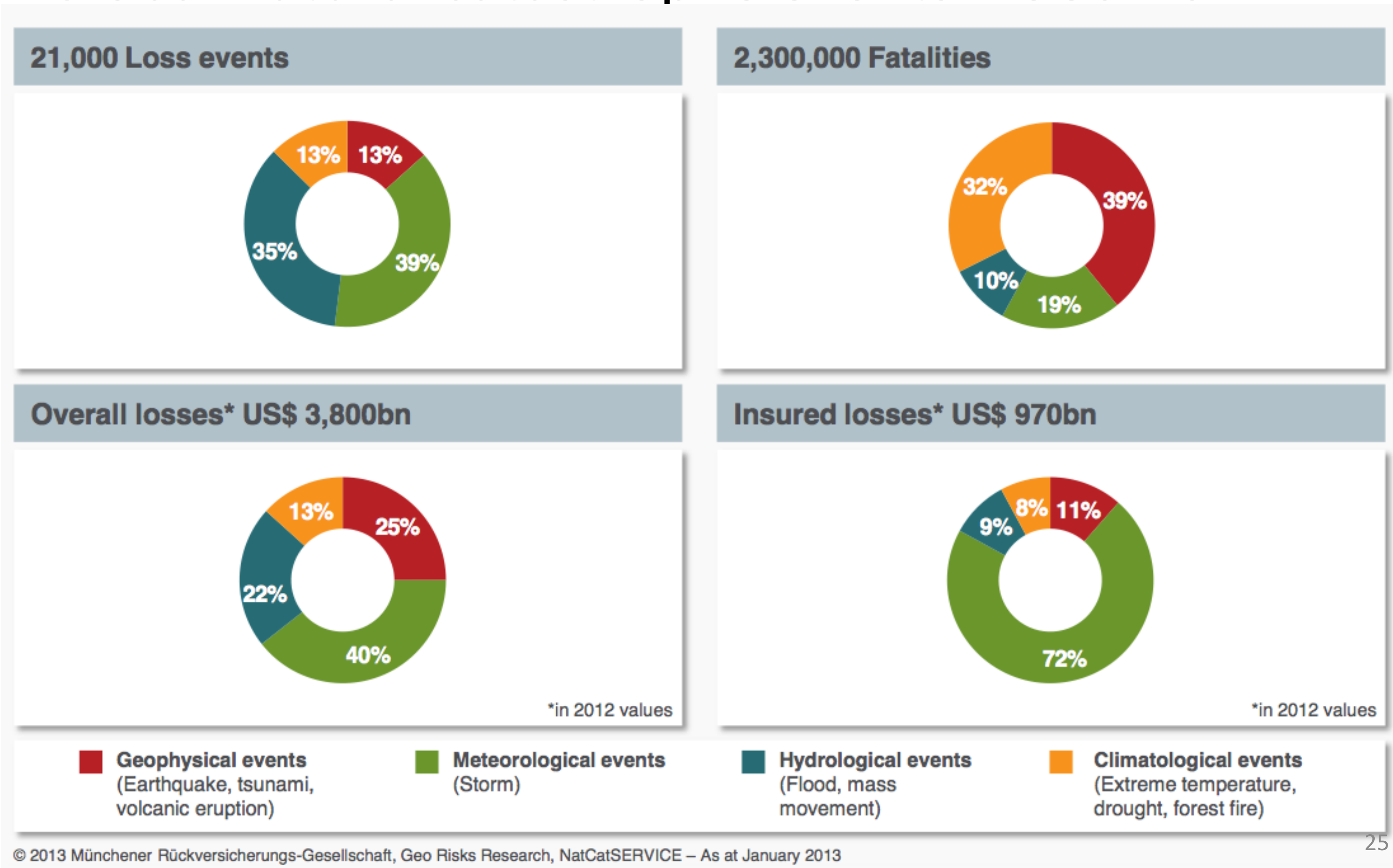
Efficient DC end-use technologies are particularly enabling….

Thinking about deployment partners

- **<u>Resiliency advocates</u>** have a hard sell…
  …. for much the same reasons as do energy efficiency advocates
  - Recognizing synergisms could help all parties
  - Non-energy benefits
  - Resilience community its own, different concept of performance
  - Already in their own deployment mode (labels, standards, etc.)
- **<u>Building code developers</u>** stovepipe resilience and building energy performance, but could integrate
- **<u>Green buildings advocates</u>** are a bit schitzo about resilience, although there is no intrinsic dilemma
- **<u>Utilities</u>** have clear interest in both angles
- **<u>Insurers</u>** care about climate-change adaptation and mitigation co-benefits, and can incentivize better practices

Insurance: disasters through their lens

Global natural catastrophe events: 1980-2012



Insurance: precedents

- Resilience
  - Meso-scale modeling based on individual building forensics
  - Product testing/rating/labeling
  - Premium credits for resilient buildings
  - Lobbying for improved codes
- Efficiency
  - 57 companies offering 130 products & services
    - Premium credits
    - Upgrade-to-Green contract amendments
    - Liability insurance for RESNET auditors

Insurance: partnerships

- World's largest industry – but have limited bandwidth
- They direct and fund 100's of $billions each year in capital replacement and reconstruction ("claims")
- They have things to teach us about risk assessment and management
- Controlling losses helps maintain insurability and affordability for consumers; also reduces public burden
- Many of the innovations we've documented were carried out in partnership with non-insurer entities
- Public insurers of private infrastructure (e.g., FEMA) as well as publicly owned infrastructure (e.g., HUD, DOD) should be at the table as well

Take-homes

- Resilience is a good "hook" for efficiency (and *visa-versa*)
- Many natural partners for EERE
- The building (energy/indoor environment) performance community has many useful things to offer to the resilience community
- Multiple potential deployment partnerships (public and private)
- Let's not allow this to be another passing fad
- Open frontier for RD&D – proposed LDRD @ LBNL to explore these avenues further

http://insurance.lbl.gov

emills@lbl.gov